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# Musculoskeletal Measures of Orofacial Pain

**James R. Fricton, DDS, MS**
TMJ and Craniofacial Pain Clinic,
School of Dentistry,
University of Minnesota,
Minneapolis, Minnesota

Musculoskeletal disorders of the stomatognathic system comprise the majority of diagnoses responsible for chronic orofacial pain. The most common signs for these disorders include tenderness, limitation in range of motion, deviation in range of motion, and joint noise. Although these signs are used routinely for diagnosis, the reliability, validity, and accuracy of their use as diagnostic criteria or outcome measures has not been established. A series of clinical studies on a Craniomandibular Index (CMI) was completed to examine these issues. Interrater and intrarater reliability of the grouped items in the CMI ranged from 0.58–0.98, with an overall correlation coefficient of 0.95 and 0.96, respectively. Pressure algometry improved reliability of muscle and joint palpation for tenderness. Tenderness, but not dysfunction, was correlated with symptom severity. Both tenderness and dysfunction improved with treatment but did not become normal. The percent agreement of these signs as diagnostic criteria for the presence and stage of a temperomandibular joint (TMJ) internal derangement was about 80% compared with arthrotomography. These studies suggest that these clinical characteristics can be used with adequate reliability and validity to diagnose and measure severity if standardized methods are used.

Musculoskeletal disorders of the stomatognathic system, termed temporomandibular disorders, comprise the majority of diagnoses responsible for chronic orofacial pain. A recent study of the prevalence of disorders in consecutive patients presenting to a facial pain clinic revealed that 76.4% had either myofascial pain, temporomandibular joint (TMJ) internal derangement, or TMJ degenerative joint disease as the primary diagnosis responsible for their chief complaints.[1] Diagnosis of these disorders is usually made using clinical signs and symptoms characteristic of each disorder. Typically, these include joint noise, tenderness of the muscles and joints, and pain, limitation, and deviation in the range of motion of the mandible. These signs and symptoms are also used routinely in clinical practice to determine the success or failure of treatment strategies. However, the reliability and validity of these signs and symptoms as either diagnostic criteria or outcome measures has not been determined. The purpose of this paper is to present results of a series of studies examining these issues.

## SIGNS AND SYMPTOMS OF TEMPOROMANDIBULAR DISORDERS

The most common symptoms of temporomandibular disorders include facial pain, headache, joint noises, and difficulty in jaw function. However, temporomandibular disorders consist of numerous specific disorders, each with its own unique set of diagnostic signs and symptoms.[2–5] For example, diagnostic criteria for myofascial pain syndrome include[5]:

1. The presence of tender areas in firm bands of skeletal muscles, tendons, or ligaments. These are termed trigger points.
2. Regional pain complaints that follow consistent patterns of referral from the trigger points.
3. Reproducible alteration of pain complaints with specific palpation of the responsible trigger points.

TMJ internal derangement is characterized by five progressive stages of clinical dysfunction involving disk displacement relative to the condyle. It is also often associated with TMJ capsulitis and its attendant pain, tenderness, and joint swelling.

Address correspondence to James R. Fricton, DDS, MS, Associate Professor, TMJ and Craniofacial Pain Clinic, Department of Diagnostic and Surgical Sciences, School of Dentistry, University of Minnesota, 6-320 Moos Tower, Minneapolis, MN 55455.



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### Stage I

Stage I is characterized by reciprocal clicking of the TMJ on opening and closing. The opening click reflects the condyle moving beneath the posterior band of the disk until it snaps into its normal relationship on the concave surface of the disk. The closing click reflects reversal of this process. The condyle moves under the posterior band of the disk until it snaps off the disk and on to the posterior attachment. The opening click occurs at a wider incisal opening than the closing click and at different points of incisal opening. As the disk becomes deformed, it begins to interfere with normal translation of the condyle.

### Stage II

Stage II begins when the disk becomes anteriorly and medially or laterally displaced relative to the condyle, blocks translation, and causes periodic locking and limitation of opening. The locking can usually be reversed immediately by the patient and becomes intermittent, depending upon biomechanical strain placed on the joint-disk apparatus. Occasionally, a patient can also exhibit an excessive opening as a result of ligament laxity and joint hypermobility, eventually resulting in open locking or subluxation of the joint.

### Stage III

Stage III is characterized by an acute, sustained closed-lock. In this situation, the disk becomes permanently lodged anteriorly and interferes with normal condylar translation. The opening is usually restricted to 20–30 mm. Minimal joint noise is present because little joint translation occurs. Subsequent to the joint dysfunction, the masticatory muscles frequently become tender and painful as a result of protective splinting of the joint.

### Stage IV

If the disk is permanently positioned anterior or posterior to its normal position, soft tissue remodeling leads to stage IV. Routine daily jaw function remodels the soft-tissue disk until the jaw opens to nearly normal. The posterior attachment and collateral ligaments accommodate to the new position with possible deposition of fibrous connective tissue. A single opening click or fine crepitus can occur as a result of irregular interferences in translation. The masticatory muscles can continue to display protective splinting and may cause further pain.

### Stage V

Soft tissue remodeling often progresses to the hard tissue remodeling of stage V. Radiographic changes become evident on the condylar head and occasionally on the articular eminences. Disk perforation and bone-to-bone contact may cause degenerative changes and coarse crepitus upon opening and closing. The muscle splinting or capsulitis associated with earlier stages may subside. If remodeling is successful, patients can progress to a normal opening with minimal pain but joint noise often persists. In other cases, the bony degenerative changes can progress with various consequences, including severe erosion, loss of vertical dimension, occlusal changes, severe joint and muscle pain, and a severely compromised jaw function.

## RELIABILITY OF SIGNS AND SYMPTOMS

A study was completed to examine the interrater reliability (two raters in one day) and intrarater reliability (one rater at two-week intervals) of the most common signs and symptoms of temporomandibular disorders.[6] Tables 1–3 and Figure 1 present the items and their definitions. Table 4 presents the correlation coefficients for each item's interrater and intrarater reliability. Mandibular movement and TMJ noise were the items with highest overall reliability, whereas intraoral palpation and subjective symptoms had lower reliability. It should be noted that the items with complete subjectivity (e.g., pain severity) and items with partial subjectivity (e.g., muscle palpation) had lower reliability than items considered more objective (e.g., mandibular movement). However, reliability of all of these were in the acceptable range.

Despite these findings, muscle and joint palpation has been previously criticized for poor reliability.[7] In an attempt to improve reliability of palpation, a pressure algometer (PAMP II) was developed and tested for interrater reliability (two raters in one day) as compared with the manual palpation technique (Figure 2).[8] The palpation technique with the pressure algometer consisted of locating the distinct muscle band or part of joint with gentle index finger pressure and then using the tip of the pressure algometer to place pressure on the band at the specific muscle location. An "ascending method of limits" technique was used to determine the pain threshold. The pain threshold was the first level at which the patient reports even the slightest pain due to ascending pressure from palpation with the pressure algometer. This level was recorded and repeated in five seconds to determine mean pain threshold for each muscle location. All the patients were given the following instructions: "Please raise your hand when the pressure first becomes even the slightest bit painful." If no pain was reported at the highest level, then this level was used as the pain threshold.

The second rater, blind to the first rater's determinations repeated the evaluation after a 15-minute rest to minimize aggravation of the trigger point. The mean value at each

**Table 1.** Items Associated with Jaw Dysfunction in the Craniomandibular Index and Their Definitions

| *Item* | *Description* |
|---|---|
| Maximum opening: | Patient is asked to open as wide as possible, and examiner measures the distance from incisal surface to incisal surface of maxillary and mandibular central incisors at the midline. Positive if 39 mm or less. |
| Passive stretch opening: | Gentle stretching by examiner beyond voluntary maximum opening and measure identical to maximum opening. Positive if 41 mm or less. |
| Restriction: | Positive if maximum opening is less than 40 mm or via subjective opinion of examiner that restriction exists for that individual. |
| Pain on opening: | Any pain, but not pressure or tightness, with stretch or with maximum opening is positive. |
| Jerky opening: | This is positive if there is not a smooth and/or continuous opening. |
| S-deviation on opening or closing: | An s-curve on opening or closing is positive if it is >2 mm from midline. |
| Lateral deviation on opening | A lateral deviation at full opening is positive if it is >2 mm from midline. |
| Protrusion: | |
| a. Pain: | Any pain, but not pressure or tightness, during or at maximum protrusion is positive. Teeth are in light contact at end of range of motion. |
| b. Limitation: | Examiner measures the distance between labial surfaces of the maxillary incisors at maxillary midline when in centric occlusion and again at maximum voluntary protrusion. It is positive if the difference between the two values is less than 7 mm. |
| Right laterotrusion: | |
| a. Pain: | Examiner marks the point on the mandibular incisors that matches the maxillary midline |
| b. Limitation: | and measures the difference between this midline and the mandibular point after maximum laterotrusion. It is positive if this is less than 7 mm. |
| Left laterotrusion: | |
| a. Pain: | Same as right laterotrusion. |
| b. Limitation: | |
| Clinically can lock open: | Voluntary or involuntary forward dislocation of the condylar head out of the glenoid fossae combined with fixation in that position (no time specified). |
| Clinically can be or is locked closed: | Voluntary or involuntary blocking of translation of the right and/or left condyle that is of short or permanent duration (fixation) as determined by manual palpation. (Condyle does not slide anteriorly). |
| Rigidity of jaw upon manipulation | Resistance to manual rotation of jaw, voluntary or involuntary. |

**Table 2.** Description of Each Item for TMJ Noise

*The TMJ noise must be audible to the patient, and the corresponding dysfunction must be palpable by examiner. For purposes of scoring, a maximum of two distinct sound types per side is allowable for scoring.*

| *Item* | *Description* |
|---|---|
| Reciprocal click | Noise made upon opening and closing from Centric Occlusion position that is reproducible on every opening and closing. Can be eliminated with anterior repositioning of jaw. |
| Reproducible opening click | Noise with every opening, no noise when closing. |
| Reproducible closing click | Noise with every closing, no noise on opening |
| Reproducible laterotrusive click | Noise with every full laterotrusive movement; no noise on opening. |
| Non-reproducible click | Present on opening or closing, or in laterotrusion, but not repeatable. |
| Crepitus (fine) contact | Fine grating noise suggestive of mild bone-on-bone contact. |
| Crepitus (coarse) | Coarse grating noise suggestive of gross bone-on-bone contact. |
| Popping | Loud sound on opening that is audible to examiner at a distance without stethoscope. |

site for the 45 comparisons for both the pressure algometer technique and manual technique then was compared using the kappa statistic for interrater agreement. This statistic was used to provide a standardized comparison of both the pressure algometer and manual technique that considers the factor of random agreement. The pressure algometer scores were converted to 0–1 scores by using the mean as the threshold value.

The results presented in Table 5 demonstrated that moderate to good reliability ($r \geq 0.40$) was demonstrated in 13–15 sites with PAMP II and in only 2–15 sites with manual palpation. A corollary to the study is experienced raters were more reliable than inexperienced raters, suggesting that palpation as expected is technique sensitive.

## RELIABILITY OF COMPOSITE INDICES

The use of the signs and symptoms to develop indices to measure severity of a disorder can be useful for epidemiology of natural progression, correlation with risk factors, and treatment outcome. This was done in a study involving the development and testing of a Craniomandibular Index.[6] The list of items was divided into those items that

**Table 3.** Items Associated with the Symptom Severity Index and Their Definitions

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SI: | How intense is your usual level of symptoms? | Zero | | | | | The most that can be imagined |
| AI: | How unpleasant or disturbing is your usual level of symptoms? | Zero | | | | | The most that can be imagined |
| TO: | How difficult is it to endure the problem over time? | No difficulty | | | | | The most that can be imagined |
| FR: | How often do the symptoms generally occur? | Never | 1/mo | | 1/day | 1/hour | Constant |
| DU: | When the symptoms occur, how long do the symptoms usually last? | Never | 1/minute | 1/hour | 1/day | 1/week | Continuous |

The symptom severity index (SSI) is calculated by adding sensory intensity (SI), affective intensity (AI), tolerability (TO), frequency (FR), duration (DU), and scope of symptoms (symptom checklist) and dividing by 6. Each subscale has a 0 to 1 range. The symptom checklist is modified version of that used by Kabat-Zinn, 1983, and can be obtained by contacting the authors.

reflect temporomandibular joint tenderness and functioning problems, termed the Dysfunction Index (DI), and those items that reflect muscle tenderness problems, termed the Muscle Index (MI). The DI includes items related to limits in range of motion, deviation in movements, pain during movement, TMJ noise during movement, and TMJ tenderness. The palpitation index (PI) includes items related to tenderness at distinct anatomic sites during intraoral palpation of jaw muscles, and extraoral palpation of jaw and neck muscles. Muscle sites such as the tongue and posterior temporalis that did not show consistent tenderness in a MPS population were not included. Each index included only those items that have the potential to change over time or with treatment. In addition, the items measuring subjective severity were combined to arrive at an composite symptom severity index (SSI). These items include sensory intensity, affective intensity, tolerability, frequency, duration, and scope of symptoms (Table 3). Reliability of these three indices presented in Table 6 were above .80 lending support for their use in epidemiological investigations.

**Table 4.** Interrater and Intrarater Reliability of Items in the Craniomandibular Index and Symptom Severity Index

| *Items* | *Intrarater Reliability (1 Rater in 2 Weeks)* | *Interrater Reliability (2 Raters in 1 Day)* |
|---|---|---|
| Mandibular movement (0–16)* | 0.98 | 0.88 |
| TMJ noise (0–4)* | 0.85 | 0.85 |
| TMJ palpation (0–6)* | 0.84 | 0.77 |
| Intraoral palpation (0–6)* | 0.68 | 0.58 |
| Extraoral palpation (0–18)* | 0.86 | 0.81 |
| Neck palpation (0–12)* | 0.85 | 0.84 |
| Symptoms | | |
| Pain (sensory)† | 0.72 | ‡ |
| Pain (affective)† | 0.85 | ‡ |
| Scope of symptoms† | 0.93 | ‡ |
| Intolerability† | 0.69 | ‡ |
| Frequency† | 0.79 | ‡ |
| Duration† | 0.85 | ‡ |

* Intraclass correlation coefficient ($n$ = 19, $n$ = 40, respectively).

† Stability using Pearson product moment correlation between scores obtained 2–3 weeks apart ($n$ = 50).

‡ Not applicable.

## VALIDITY OF SIGNS AND SYMPTOMS

To use these aggregate measures in epidemiological research, validity of them must also be supported. To test validity, four studies were completed; 1) comparing the CMI and SSI scores at pretreatment with posttreatment scores; 2) comparing the CMI with the SSI; 3) comparing the CMI within the diagnostic groups including normals; and 4) compare the CMI with Helkimo indices.[9]

Table 7 shows mean scores and correlations for confirming construct validity. Pre and posttreatment scores for the CMI and Symptom Severity Index were compared using the Student $t$-test. Spearman's Rank Order Correlation Coefficient was used to determine correlation between the CMI, DI, PI, and the Symptom Severity Index. Patients who were treated reported a significant improvement in scope of symptoms ($P \leq .001$), sensory ($P \leq .001$), and affective intensity ($P \leq 0.05$), frequency ($P \leq$

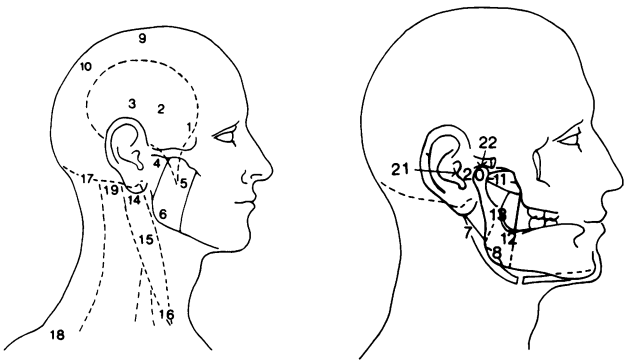


**Figure 1.** The items associated with the muscle tenderness in the craniomandibular index and their definitions

*Structure*

*Muscle: Extra-oral*
1. Anterior Temporalis
2. Deep Temporalis
3. Middle Temporalis
4. Deep Masseter
5. Anterior Masseter
6. Inferior Masseter
7. Posterior Digastric
8. Medial Pterygoid
9. Vertex
10. Reference Point

*Muscle: Intra-oral*
11. Lateral Pterygoid Site
12. Medial Pterygoid
13. Temporalis Insertion

*Muscle: Neck*
14. Superior Sternocleidomastoid
15. Middle Sternocleidomastoid
16. Inferior Sternocleidomastoid
17. Insertion of Trapezius
18. Upper Trapezius
19. Splenius Capitis

*TMJ*
20. Lateral Capsule
21. Posterior Capsule
22. Superior Capsule

*Description:* Palpation is performed by first locating the distinct muscle band or part of joint and then palpating using the sensitive spade-like pad at the end of the distal phalanx of the index finger using firm pressure (approximately 1 lb per square inch). The patient is asked, "Does it hurt or is it just pressure?" The response is positive if palpation produces a clear reaction from the patient: *i.e.*, palpebral response, or if patient stated that the palpation "hurt," indicating that the site was clearly more tender than surrounding structures or contralateral structure. Any equivocal response by the patient would be scored as negative. Site #10 can be used as a reference site to demonstrate to the patient what "pressure" feels like. Due to poor accessibility of lateral pterygoid site, the fifth finger should be used to palpate with the patient's jaw in laterotrusion to the ipsilateral side. Palpation of the lateral and superior aspects of the TMJ is accomplished with full mouth opening. The deep masseter is palpated immediately below the notch in the zygomatic arch with the mouth closed.

.009), and tolerability of pain ($P \leq .009$). Duration of pain remained the same ($P = .439$). They also showed a significant improvement in objective findings as measured by DI ($P < .001$), PI ($P < .001$), and CMI ($P < .001$). Correlation between the Craniomandibular Index and the Symptom Severity Index at pretreatment was also significant ($r = 0.46$, $P < .01$). This was due to correlation with the palpation Index ($r = 0.53$, $P \leq .005$) versus the Dysfunction Index ($r = 0.16$, $P \geq 0.24$).

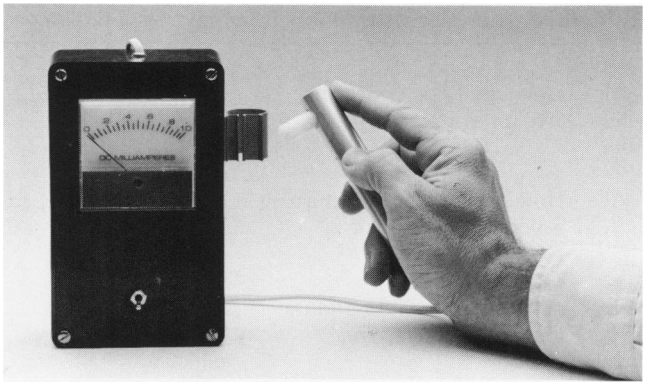

**Figure 2.** Pressure algometer to improve reliability of muscle and joint palpation

Table 8 shows the mean scores of each index for different diagnoses to determine if the CMI was sensitive enough to distinguish between them. The DI increased in severity from early (0.32) to middle (0.37) to acute locking (0.43) to late stage (0.47) internal derangements. TMJ noise was higher with early (1.81) and middle stage (2.24) internal derangements as compared with acute locking (1.41) and late stage (1.37) internal derangements. The PI was higher with myofascial pain dysfunction (MPD) than each stage of TMJ internal derangements (0.50 versus 0.34, 0.45, 0.40, 0.46, respectively), whereas the DI was relatively low with MPD patients compared with each stage of internal derangement (0.29 versus 0.32, 0.37, 0.43, 0.47, respectively). Tenderness of the TMJ capsule was increased from early to middle to acute locking to late stage internal derangements (1.63, 2.24, 2.75, 3.31, respectively) but was lower with MPD (1.84). The normal controls were near zero for the DI, PI, and CMI (0.05, 0.08, 0.07).

Criterion validity was determined by calculating the correlation between Helkimo's Dysfunction Index and the CMI using Spearman's Rank Order Correlation Coefficient. The correlations between Helkimo's Dysfunction Index with the CMI is 0.64, with the DI is 0.65 and with the PI is 0.52. Each of these are positive and significant ($P < .001$).

## ACCURACY OF DIAGNOSTIC CRITERIA

A study was completed to determine how accurate specific diagnostic criteria were in diagnosing the presence and stage of TMJ internal derangement compared to arthrotomography.[10]

Sixty subjects with complaints relative to the temporomandibular joints (TMJ) were involved in this study. Forty-two subjects had bilateral arthrotomography and 18 had unilateral arthrotomography for a total of 102 arthrotomo-

**Table 5.** Interrater Reliability of Muscle Palpation Was Higher with the Pressure Algometer then with Manual Finger Palpation[8]

| | *MPS Patients with PAMP Mean Pain Threshold* | | | *MPS Patients with Manual Percentage Positive Responses* | | |
|---|---|---|---|---|---|---|
| *Muscle* | *Rating** | *Rating†* | *K-Value†* | *Rating** | *Rating†* | *K-Value†* |
| Anterior temporalis | .37 | .36 | .55‡ | .46 | .47 | .51‡ |
| Deep temporalis | .40 | .39 | .38 | .56 | .56 | .32 |
| Middle temporalis | .48 | .48 | .49‡ | .42 | .24 | .34 |
| Deep masseter | .44 | .35 | .36 | .76 | .82 | .27 |
| Anterior masseter | .35 | .36 | .63‡ | .53 | .71 | .24 |
| Inferior masseter | .32 | .34 | .68‡ | .67 | .73 | .24 |
| Posterior digastric | .26 | .26 | .40‡ | .84 | .78 | .35 |
| Medial pterygoid | .26 | .24 | .51‡ | .58 | .73 | .27 |
| Vertex | .67 | .58 | .69‡ | .16 | .24 | .17 |
| Superior SCM* | .44 | .44 | .46‡ | .27 | .27 | .02 |
| Middle SCM* | .24 | .21 | .58‡ | .56 | .49 | .60‡ |
| Splenius capitis | .47 | .48 | .68‡ | .76 | .56 | .33 |
| Trapezius insertion | .45 | .47 | .54‡ | .73 | .56 | .38 |
| Upper trapezius | .50 | .51 | .46‡ | .64 | .73 | .37 |
| TMJ capsule (lateral) | .28 | .28 | .46‡ | .49 | .71 | .17 |

* Sternocleidomastoid.
† kappa statistic of interrater agreement.
‡ Fair to good reliability.

graphic evaluations. Due to the possible bias of abnormal anatomy in one TMJ affecting the presentation of the contralateral TMJ, the 42 individuals with bilateral arthrotomography (i.e., 84 joints) were randomly distributed between two samples. Sample A consisted of the right or left randomly assigned arthrograms from the 42 individuals with bilateral arthrograms plus 18 arthrograms from the remaining individuals with unilateral arthrograms. Sample B consisted of the 42 remaining contralateral arthrograms from the individuals with bilateral arthrotomography. The arthrotomographic diagnoses from both samples was normal in 17 joints (16.7%), ID with reduction in 58 joints (56.8%), TMJ ID without reduction/acute in 5 joints (4.9%), and TMJ ID without reduction/chronic in 22 joints (21.6%). In addition, a diagnosis of TMJ osteoarthritis was found in 14.7% of all joints evaluated.

**Table 6.** Reliability of the Overall Craniomandibular Index (CMI) and Symptom Severity Index (SSI)[9]

| *Index* | *Intrarater Reliability (1 Rater in 2 Weeks)* | *Interrater Reliability (2 Raters in 1 Day)* |
|---|---|---|
| CMI (overall)* | 0.96 | 0.95 |
| Dysfunction index* | 0.92 | 0.84 |
| Muscle index* | 0.86 | 0.87 |
| SSI (overall)† | 0.89 | ‡ |

* Intraclass correlation coefficient.
† Pearson's correlation coefficient.
‡ Not applicable.

Osteoarthritis was distributed among all stages of TMJ ID. The clinical history, examination, and tomographic findings were used to construct the diagnostic criteria (Table 9). Discriminant analysis was used on sample A to evaluate the relative predictive value of each individual variable and to generate the diagnostic criteria most predictive of each stage of TMJ ID. The diagnostic criteria were then tested on sample B. Modification of the diagnostic criteria as generated from sample A was accomplished and retested against sample B. By dividing the total sample into two samples, A and B, it was also possible to cross validate the predictiveness of the criteria.

For sample A, the overall percent agreement between the arthrogram and the diagnostic criteria was 77.8%. Specifically, 80% of the normal joints, 81.5% of the ID with reduction, 50% of the ID without reduction/acute, and 76.9% of the ID without reduction/chronic were correctly classified.

Sample B was used to retest the model generated from sample A. In this way, it was possible to test the validity of the diagnostic criteria on a separate set of data. Overall, the percent agreement between the arthrogram and the diagnostic criteria was 70.0%. The predictiveness of the criteria was essentially unchanged for joints with a diagnosis of normal or TMJ ID with reduction. However, for TMJ ID without reduction, both acute and chronic, percent agreement between predicted and actual group membership declined relative to sample A.

The diagnostic criteria then were modified by removing tomographic evaluation to retest the model's predictiveness without this variable. The percent agreement be-

**Table 7.** Comparison of Pretreatment and Posttreatment Scores for the Craniomandibular Index (CMI) and Symptom Severity Index and Correlation Between Them[6]

| | *Pretreatment Scores (Mean) N = 24* | *Posttreatment Scores (Mean) N = 24* | *P-Value (Total)* | *Correlation Coefficient with Symptom Severity Score at Pretreatment* r | *P-Value* |
|---|---|---|---|---|---|
| Craniomandibular index (0–1) | .37 | .21 | .001* | .46 | .01* |
| Dysfunction index (0–1) | .24 | .09 | .001* | .16 | .24 |
| Palpation index (0–1) | .51 | .32 | .001* | .53 | .005* |
| Symptom severity index | .53 | .28 | .009* | | |
| Scope of symptoms | .20 | .07 | .001* | | |
| Sensory intensity | .58 | .18 | .001* | | |
| Affective intensity | .50 | .35 | .05* | | |
| Frequency | .65 | .40 | .009* | | |
| Duration | .50 | .41 | .439 | | |
| Tolerability | .53 | .28 | .009* | | |

* Significant ($P \leq .05$).

**Table 8.** Comparison of the Mean Scores for the Craniomandibular Index with Different Diagnoses Compared to a Normal Control Population[6]

| | *N* | *Mandibular Movement* | *TMJ Noise* | *Dysfunction Index* | *Muscle Extraoral* | *Muscle Neck* | *Muscle Intraoral* | *TMJ Capsule* | *Palpation Index* | *Mandibular Index (CMI)* |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0–16 | 0–4 | 0–1 | 0–18 | 0–12 | 0–6 | 0–6 | 0–1 | 0–1 |
| TMJ internal derangement | | | | | | | | | | |
| Early stage | 16 | 4.63 | 1.81 | .32 | 6.06 | 4.19 | 3.19 | 1.63 | .34 | .33 |
| Middle stage | 25 | 5.12 | 2.24 | .37 | 9.00 | 5.36 | 3.28 | 2.24 | .45 | .41 |
| Acute lock | 12 | 7.25 | 1.41 | .43 | 7.00 | 4.91 | 3.17 | 2.75 | .40 | .42 |
| Late Stage | 19 | 8.00 | 1.37 | .47 | 8.00 | 5.21 | 3.95 | 3.21 | .46 | .47 |
| Myofascial pain dysfunction | 25 | 4.72 | 1.08 | .29 | 9.88 | 6.56 | 3.56 | 1.84 | .50 | .40 |
| Control* | 25 | .68 | .32 | .05 | 1.76 | .64 | .84 | .12 | .08 | .07 |

* $P \leq .001$ when comparing controls with each illness group.

**Table 9.** Diagnostic Criteria to Differential Normal Joints and Joints with Each Stage of TMJ Internal Derangement[10]

| *Normal* | *ID with Reduction* | *ID without Reduction/Acute* | *ID without Reduction/Chronic (2 Sets of Criteria are Predictive)* | |
|---|---|---|---|---|
| History: None | None | A) Positive history of mandibular limitation | A) Positive history of TMJ noise | A) Positive history of TMJ noise |
| Exam: | | | | |
| A) No reciprocal click | A) Reciprocal click or popping present | A) No reciprocal click | A) Positive coarse crepitus | A) No reciprocal click |
| B) No coarse crepitus | B) No coarse crepitus | B) No coarse crepitus | | B) No coarse crepitus |
| C) Passive stretch ≥40 mm | C) Passive stretch ≥35 mm | C) Maximum opening ≤35 mm | | C) Joint sound other than A & B |
| D) Lateral movements ≥7 mm | | D) Passive stretch <40 mm | | |
| E) If S-curve deviation is present, then joint must be silent | | E) Contralateral movement <7 mm | | |
| | | F) No S-curve deviation | | |
| Tomography: | | | | |
| A) No decreased translation in ipsilateral condyle | None | A) Decreased translation of ipsilateral condyle | A) None | A) Ipsilateral condyle has: 1. Decreased translation, or 2. Positive osseous changes |
| B) No osseous changes | | | | |

tween the diagnostic criteria and the arthrographic exam, overall, was not changed. For sample A, the overall percent agreement without tomography was 79.6% as compared with 77.8% with tomography. For sample B, the overall percent agreement without tomography was 67.5% as compared with 70% with tomography. When combining sample A and B, the overall percent agreement was 75% with or without tomography.

To evaluate the accuracy of the diagnostic criteria with this sample population, sensitivity and specificity were calculated. Sensitivity is defined as the percentage of those who have the disease and are so indicated by the test. Specificity is defined as the percentage of those who do not have the disease and are so indicated by the test. To calculate these values, all stages of TMJ ID were combined into a category labeled disease. For sample A, the sensitivity and specificity of the complete diagnostic criteria was 86% and 80%, respectively. Excluding the tomographic variables, it was 93% and 80%, respectively. For sample B, the sensitivity and specificity of the complete diagnostic criteria was 82% and 67%, respectively. Combining sample A and B, the sensitivity and specificity of the complete diagnostic criteria was 85% and 81%, respectively. Excluding the tomographic variables, it was 88% and 75%, respectively.

## DISCUSSION

This series of studies demonstrate that the clinical characteristics of temporomandibular disorders can be used with adequate reliability and validity to diagnose and measure severity of the disorder. However, this is possible only when standardized definitions and methods are used with experienced raters. Users must be aware of numerous potential errors and follow strict methodologic guidelines to assure accuracy and reproducibility of results. Because of the subjective nature of some items, it is recommended that the same rater, blind to the management status of the patient, perform pre- and post-evaluations. If multiple raters are used, it is recommended that the raters discuss all items with each other, compare scoring of demonstration subjects before the study, and use a pressure algometer for muscle palpation to standardize palpation pressure. Diagnostic criteria are particularly helpful in studies of broad scale general populations when imaging is not possible. However in clinical populations, imaging is recommended for TMJ internal derangements without reduction (chronic) and selectively, in other joint disorders to improve accuracy. In clinical outcome studies, consideration must also be made to include a comparison with a control group, to use both objective and subjective measures of outcome at multiple posttreatment intervals, to include standardized measurement of potential risk factors for treatment failure, and to determine the differential effects of treatment on diagnostic subgroups. If specific conclusions regarding outcome studies are to be derived, these minimal standards of clinical research need to be followed.

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